STUDIES OF DURABILITY AND EFFECT ON MATERIAL PROPERTIES OF DIFFERENT ANTIBACTERIAL PRODUCTS

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Introduction

Fabric treatments imparting bactericide characteristics are highly desired by the apparel, home furnishings, and medical industries. However, conventional processes used to impart such characteristics have a major drawback. That is, these effects are not permanent and the properties of the material may be altered. Laundering or wearing of the treated fabric causes leaching or erosion of the agents responsible for imparting the desired characteristics. This problem has resulted in research efforts to develop durable treatments [1-4]. This includes microencapsulated active agents that operate by controlled release such as silver salts, oxidising agents, reducing agents, and various types of antibacterial products [4]
Microcapsules are applied in numerous fields, such as pharmaceuticals, cosmetics, detergents, and other applications where it is important to liberate the encapsulated material slowly [4, 5].
In our particular case, the fixation of the capsules to the fabric is a crucial factor to achieve the satisfactory fixation level to rendering desired bioactivity.The microcapsules are usually applied with a binder by impregnation. The binder, however, has drawbacks such as loss of breathabilility due to the formation of a continuous film. It was shown in a previous presentation that if the binder is targeted, such as spraying the binder, these properties are slightly improved [6].
Another possibility is to use of graft polymers, homopolymers, and/ or copolymerization on to the fibre of antibacterial properties [7,8], or by chemical modification of the fibre by formation of covalent bonds with quaternary ammonium salts having expected bactericide properties [3, 9].
This work aimed the binding to the textile fibres active components that are expected to have antimicrobial activity. In this work the components tested were respectively a microencapsulated antibacterial product and a soluble quaternary ammonium salt covalently linked to the fibre.
The efficiency of micro encapsulation and the release of the antibacterial product were evaluated by antibacterial activity.

Experimental

Materials
100% cotton fabric and polyester nonwovens was used in these studies.
Most of the chemicals were purchased to Aldrich (Germany)
Microcapsules (MC) and self-adhesive microcapsules were kindly provide by Micropolis (Portugal)

Microcapsules application

Samples of non-woven made up of 100% polyester were sprayed (on both sides) with a suspension of microcapsules in binder and alternatively with a suspension of self-adhesive microcapsules. The quantity of microcapsules was about 30% higher in the case of self-adhesive than with binder (35% for self-adhesive and 20% for binder), since these are double walled microcapsules with an inert second thermoplastic wall, and this way total active agent present in the non-woven should be equivalent.
They were then put through a stenter at 150ºC for fixing.

Chemical modification of fibre

A solution consisting of 5 or 90 gL^{-1} of quaternary ammonium salt (60% solution) and 1.02 or 20.2 gL^{-1} of sodium hydroxide respectively was applied to the cotton material by impregnation method. The wet pickup was 70%. By exhaustion method it was applied 15% spf of 3-Chloro-2- hydroxypropyltrimethylammonium chloride (60% solution), with R:B 1:20 and 2.75 gL-1 of sodium hydroxide.

Testing methods

The nitrogen content of the modified fabric samples were measure by using a modified Kjeldahl method according to ASTM standard test method E 258-257 (1987) and elementary analysis using Leco CHN analyser.
Determination of antibacterial activity of the materials samples was evaluated according AATCC test method 147.
Air Permeability was measured in the Textest AG Instruments FX 3300 (NP EN ISO 9237:1997 – Textiles determination of permeability of fabrics to air)
Permeability to vapor was measured in Shirley M261 Water Vapor Permeability Tester (BS 7209:1990 – Water vapor permeable apparel fabrics) and in the Permetest.
Washing tests were made as described by ISO 105 B01 and ISO 105C06 modified.

Results and discussion

Figure 1 presents the microencapsulated bioactive product on fibre.

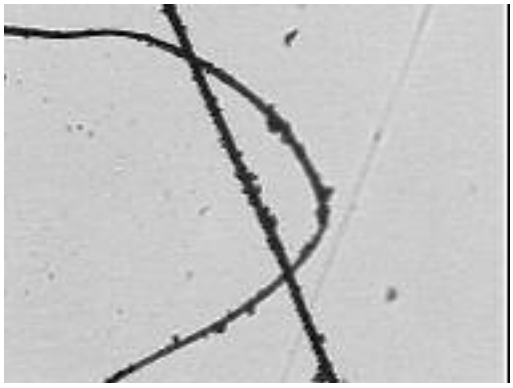

Figure 1- Antimicrobial encapsulated product on non-woven polyester fabric

The comparasion of the modified materials with standard samples (table 1) shown that the permeability was changed in both cases but with more strong effect in the case of the binder

application .The air permeability of the sample with the self-adhesive microcapsules is more than twice that obtained with the sample with binder sprayed on the non-woven. The water steam permeability is also significantly higher by both methods tested.

Table 1. Air and vapor permeability values (medium of twelve tests) for non-woven with micropsules (MC) fixed with binder and with self-adhesive MC

Sample	Air Permeability ($L/m^2/s$)	Water Steam Permeability (%)	Water Steam Permeability (%)
Control	5526	44.4	77.7
MC Self-adhesive	3940	30.1	79.2
MC + binder	1070	20.3	60.5

Treated non-woven samples were subjected to repeated launderings using conditions as difined in ISO 105 B01 and. ISO 105C06 modified.
Laundering durability was evaluted by weight lost after five washe cycles as results presented at figure 2:

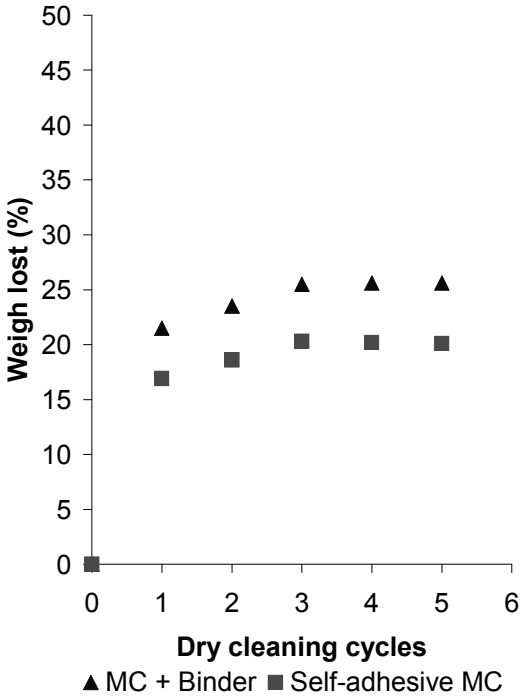

Figure 2- Laundering durability of non-woven with antimicrobial microencapsulated product

The weight lost of the modified product was lower in self-adhesive MC sample than in the case with the binder application. At the first washe cycle, the weight lost of the microencapsulated sample with Mc plus binder was 20 % and it was only 15% for the self-adhesive MC samples. In both cases after the 3 washing cycle the weight lost stabilize.

Some laundering tests were performed in self-adhesive MC sample based in standard method ISO 105C06 modified (30 minutes, without peroxide and sodium carbonate), and the results are present in figure3

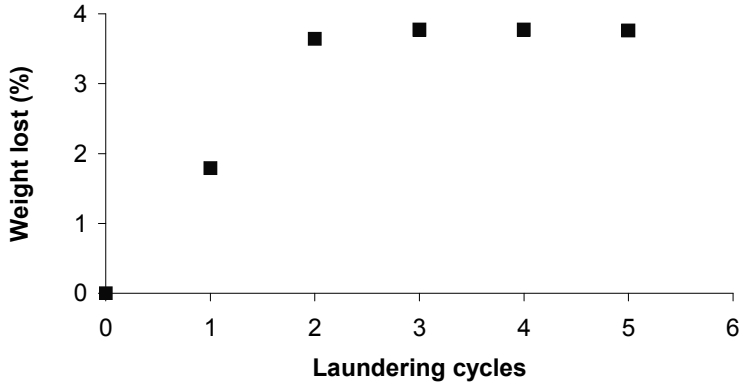

Figure 3- Laundering tests of self-adhesive MC sample (ISO 105C06 modified)

Despite the aggressivity of the washing test for this kind of samples (non-woven), only 4 % of weight was lost after the second cycle and this lost stabilised at after the third wash cycle.

Quaternary ammonium salt covalently linked to the fibre

The efficiency of the soluble application of the quaternary ammonium salt was evaluated by determination of nitrogen content before and after washes.

Since differents amounts of amines were bonded to the cotton, the samples present different content of nitrogen corresponding to a proportional antimicrobial activity of the material.

The maximum nitrogen content obtained for the sample that was applied impregnation method was 0.100+/-0.050% per weight of material.

The antimicrobial activity of treated samples was verified by the qualitative test AATCC 147.

Summary

Microcapsules with self-adhesive characteristics were applied to non-woven polyester materials. For application to non-wovens, the fixation of microcapsules into a structure is an additional problem that cannot be handled the same way as a fabric in finishing and maintaining original characteristics of the material. To these structures, microcapsules were applied by spraying and impregnation, and properties such as air and vapour permeability were evaluated after application. The use of self-adhesive microcapsules shown better results in terms of durability to standard washing and dry cleaning tests and small lost of the properties of the textile material when compared to the untreated sample.

The soluble quaternary ammonium salt, were applied by exhaustion and impregnation methods. The application process was optimised and their efficiency was evaluated by nitrogen content. The impregnation method was the best efficient and only a 5 gL^{-1} of quaternary ammonium salt was needed to impart desired functionality to the fibre. The nitrogen determinations as measure of the increase of the amino compound on fabric were consistent with antibacterial activity of the treated fabrics.

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